Evaluation Report of NIH K-12 Program

Title: Evaluation Report for the NIH3 Module, *Sleep, Sleep Disorders and Biological Rhythms*

Date: 2001

Description:
This report evaluates one component within the NIH K-12 program, the NIH Curriculum Supplements. The NIH Curriculum Supplements are K-12 teacher's guides to two weeks' of lessons that explore the science behind current health topics. The modules are sent free of charge upon request to educators across the United States. Over 50,000 educators have one or more curriculum supplement.

This study specifically examines the results of the field tests conducted during the development of:

Sleep, Sleep Disorders and Biological Rhythms (Grades 9 – 12)

This study was designed to determine the effectiveness of the module as a supplementary addition in the K-12 science curriculum. The field test sites were selected from volunteers who were chosen to maximize inclusion of various races, ethnicities, and geographic regions. The evaluation consisted of a field test with close-to-complete instructional materials. The surveys measured student knowledge using a pre/post test. The teachers also commented on the effectiveness of the lessons and their implementation. These resulted were used to identify strengths that were highlighted and weaknesses that were corrected in the final draft. The teachers' comments were included in the final draft as "tips from teachers" on specific lessons.

BSCS NIH3 Module: Biology of Sleep
Final Evaluation Report
May 2001

INTRODUCTION

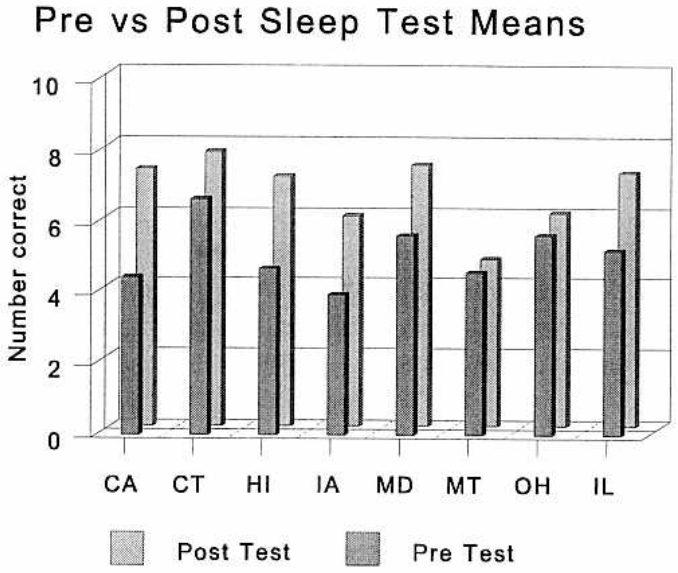
This final evaluation report analyzes current field test evaluation data on the NIH3 sponsored *Biology of Sleep* module developed and implemented by BSCS in Colorado Springs. This module was developed under a contract from the National Institutes of Health National Heart, Lung, and Blood Institute. It was nationally field tested in California, Connecticut, Hawaii, Iowa, Maryland, Montana, Ohio and Illinois from February 2001 through May 2001. The data for this summary report was generated from all eight sites. There were four types of data collected: 1) pre-post module tests; 2) student surveys; 3) teacher surveys; 4) classroom observations.

The first data item consisted of two (i.e., pre- and post-tests) 10 item multiple choice and short answer test items keyed to information distributed across the six classroom lessons (see Appendix A). After the module was completed, students were asked to fill out a two page opinion survey about the overall module and specific lessons (see Appendix B for this form). The teacher surveys provided an opportunity to provide feedback on specific activities (see Appendix C for this form). Teachers were also encouraged to write their observations directly in the margins of the Field Test Notebook. Classroom observations were made by the evaluator while visiting the classrooms (see Appendix F). For the *Biology of Sleep* module the project evaluator, Dr. Coulson, was able to observe classes in Maryland (i.e., Sanford Herzon in Rockville) and Connecticut (i.e., Frank LaBanca in Stamford). In addition to classroom visits by the project evaluator, BSCS and NIH staff also visited sites participating in the *Biology of Sleep* module. Appendix D contains the verbatim comments of the students from the two page opinion survey and Appendix E contains the teacher narrative comments from the field test sites.

RESULTS

In Figure 1 the pre-post averages are plotted for each of the eight field test locations.

Figure 1



Each state pre-post test difference was tested using a paired t-test procedure. Six of the eight mean comparisons were statistically significant at the .01 alpha level. In all sites the post-test was higher than the pre-test. Table 1 below gives the actual tested means.

Table 1
Sleep Pre-Post Test Means

		Pre Test Means	Post Test Means
California *	(N=89)	4.41	7.39
Connecticut *	(N=30)	6.67	7.77
Hawaii *	(N=74)	4.69	7.06
Iowa *	(N=16)	3.94	5.94
Maryland *	(N=32)	5.44	7.41
Montana	(N=73)	4.58	4.83
Ohio	(N=75)	5.66	6.04
Illinois *	(N=77)	5.60	7.29

* statistically significant; $p < .01$

The Student Survey form (Appendix B) contained three objective questions and two open ended questions about the module. Surveys were completed anonymously with 83 surveys from California, 64 from Connecticut, 72 from Hawaii, 17 Iowa, 74 from Montana, 79 from Ohio, and 114 from Illinois. Overall, eighty eight percent of the students indicated that the *Biology of Sleep* module was *"just right"*. Table 2 below shows the percentage distribution for the first survey question by state.

Table 2
Sleep Overall Student Perception

	Too Easy	Just Right	Too Difficult
California	9.6%	89.2%	1.2%
Connecticut	28.6%	69.8%	1.6%
Hawaii	4.2%	93.1%	2.8%
Iowa	0%	88.2%	11.8%
Maryland	NA	NA	NA
Montana	5.4%	94.6%	0%
Ohio	8.9%	86.1%	5.1%
Illinois	7.9%	92.1%	0%

The second question on the student survey was an adjective check list, where the students could select one or more adjectives to apply overall to the *Biology of Sleep* module. Table 3 summarizes the percentages of students that applied each adjective; the sum of the percentages for each field test site exceed hundred percent because students may select more than one adjective.

Table 3
Sleep Adjective Check List by State

	Fun	Confusing	Active	Stimulating	Challenging
CA	66%	23%	52%	24%	49%
CT	73%	33%	57%	50%	10%
HI	85%	29%	43%	44%	43%
IA	65%	24%	59%	41%	47%
MD	NA	NA	NA	NA	NA
MT	68%	22%	57%	14%	14%
OH	67%	23%	52%	35%	30%
IL	64%	10%	68%	38%	46%

The final part of the quantitative student survey questions focused on the rated *clarity* and *engagement* of the six lessons in the *Biology of Sleep* module. Tables 4 and 5 present the overall percentage distributions for these six lessons. Figure 2 shows the site-by-site means on a four-point scale, where 4 indicates high clarity or engagement, and 1 indicates low clarity or engagement.

Table 4
Student Survey: Clarity Distribution for Six Sleep Chapters

	High	Medium High	Medium Low	Low
1. Pre-Lesson: Sleep Diary	53.4%	37.6%	8.6%	.4%
CA	70.7%	22.7%	5.3%	1.3%
CT	55.0%	33.3%	10.0%	1.7%
HI	63.8%	29.0%	7.2%	0%
IA	28.6%	50.0%	21.4%	0%
MD	NA	NA	NA	NA
MT	62.9%	25.7%	11.4%	0%
OH	34.8%	55.1%	10.1%	0%
IL	43.1%	50.5%	6.4%	0%

	High	Medium High	Medium Low	Low
2. What Is Sleep?	42.3%	45.1%	11%	1.6%
CA	50.6%	40.7%	6.2%	2.5%
CT	42.9%	44.4%	11.1%	1.6%
HI	50.7%	42.3%	7.0%	0%
IA	56.3%	37.5%	6.3%	0%
MD	NA	NA	NA	NA
MT	45.9%	29.7%	21.6%	2.7%
OH	25.6%	60.3%	12.8%	1.3%
IL	37.6%	51.4%	9.2%	1.8%
3. Houston We Have a Problem	36%	34.6%	22.5%	6.9%
CA	34.2%	31.6%	24.1%	10.1%
CT	29.7%	35.9%	26.6%	7.8%
HI	36.6%	39.4%	21.1%	2.8%
IA	31.3%	43.8%	18.8%	6.3%
MD	NA	NA	NA	NA
MT	27.0%	37.8%	24.3%	10.8%
OH	28.2%	33.3%	33.3%	5.1%
IL	52.7%	30.4%	11.6%	5.4%
4. Do You Have Rhythm?	31.7%	41.1%	21.3%	5.9%
CA	32.1%	35.8%	18.5%	13.6%
CT	25.8%	35.5%	29.0%	9.7%
HI	40.6%	34.8%	18.8%	5.8%
IA	11.8%	64.7%	23.5%	0%
MD	NA	NA	NA	NA
MT	37.1%	48.6%	11.4%	2.9%
OH	20.8%	49.4%	27.3%	2.6%
IL	36.3%	38.1%	22.1%	3.5%
5. Evaluating Sleep Disorders	44.3%	42.5%	10.9%	4.6%
CA	40.5%	49.4%	6.3%	3.8%
CT	56.3%	37.5%	6.3%	0%
HI	53.5%	42.3%	4.2%	0%
IA	12.5%	56.3%	31.3%	0%
MD	NA	NA	NA	NA
MT	35.1%	43.2%	18.9%	2.7%
OH	30.8%	47.4%	19.2%	2.6%
IL	54.5%	34.8%	7.1%	3.6%

	High	Medium High	Medium Low	Low
6. Drowsy Driving Policy	50.7%	34.5%	10.1%	4.6%
CA	75.0%	18.8%	3.1%	3.1%
CT	45.3%	43.8%	7.8%	3.1%
HI	61.4%	37.1%	1.4%	0%
IA	43.8%	43.8%	6.3%	6.3%
MD	NA	NA	NA	NA
MT	45.9%	32.4%	13.%	8.1%
OH	42.3%	37.2%	16.7%	3.8%
IL	43.1%	34.9%	14.7%	7.3%

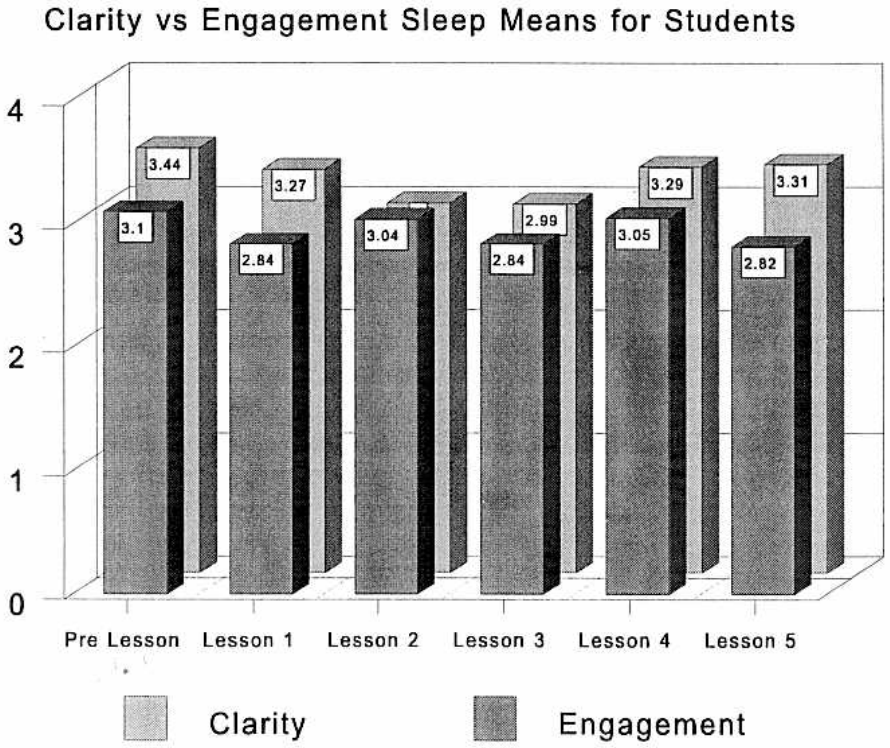
Table 5
Student Survey: Engagement Distribution for Six Sleep Chapters

	High	Medium High	Medium Low	Low
1. Pre-Lesson: Sleep Diary	37.6%	40.4%	16.5%	5.6%
CA	40.8%	39.4%	9.39%	9.9%
CT	38.7%	46.8%	12.9%	1.6%
HI	48.6%	30.0%	17.1%	4.3%
IA	25.0%	50.0%	25%	0%
MD	NA	NA	NA	NA
MT	38.2%	41.2%	20.6%	0%
OH	38.0%	38.0%	18.3%	5.6%
IL	29.1%	43.6%	17.3%	10.0%
2. What Is Sleep?	21.1%	46.9%	26%	5.9%
CA	33.3%	44.9%	11.5%	10.3%
CT	22.2%	52.4%	19.0%	6.3%
HI	23.9%	53.5%	18.3%	4.2%
IA	25.0%	31.3%	43.8%	0%
MD	NA	NA	NA	NA
MT	22.2%	41.7%	27.8%	8.3%
OH	8.0%	49.3%	37.3%	5.3%
IL	17.7%	45.1%	33.6%	3.5%
3. Houston We Have a Problem	39.3%	35%	16.6%	9.2%
CA	31.3%	27.5%	21.3%	20.0%
CT	45.3%	35.9%	10.9%	7.8%
HI	40.8%	35.2%	19.7%	4.2%
IA	37.5%	43.8%	12.5%	6.3%
MD	NA	NA	NA	NA
MT	30.6%	41.7%	11.1%	16.7%
OH	26.0%	39.7%	28.8%	5.5%
IL	45.9%	31.0%	10.6%	3.5%

	High	Medium High	Medium Low	Low
4. Do You Have Rhythm?	26.3%	39.7%	25.7%	8.4%
CA	32.4%	31.1%	17.6%	18.9%
CT	17.7%	30.6%	40.3%	11.3%
HI	31.4%	47.1%	14.3%	7.1%
IA	6.7%	73.3%	20.0%	0%
MD	NA	NA	NA	NA
MT	20.6%	41.2%	32.4%	5.9%
OH	19.7%	48.7%	26.3%	5.3%
IL	34.2%	34.2%	26.3%	5.3%
5. Evaluating Sleep Disorders	36%	38.9%	20.2%	4.9%
CA	35.1%	41.6%	13.0%	10.4%
CT	49.2%	31.7%	15.9%	3.2%
HI	40.8%	39.4%	15.5%	4.3%
IA	18.8%	50.0%	31.3%	0%
MD	NA	NA	NA	NA
MT	16.7%	44.4%	33.3%	5.6%
OH	25.0%	38.2%	30.3%	6.6%
IL	48.6%	36.0%	13.5%	1.8%
6. Drowsy Driving Policy	29%	34.3%	26.1%	10.6%
CA	53.1%	28.1%	6.3%	12.5%
CT	18.8%	39.1%	28.1%	14.1%
HI	34.3%	41.4%	21.4%	2.9%
IA	31.3%	56.3%	12.5%	0%
MD	NA	NA	NA	NA
MT	16.7%	41.7%	33.3%	8.3%
OH	28.9%	32.9%	30.3%	7.9%
IL	25.5%	23.6%	33.6%	17.3%

The student survey defined clarity as: *"If you felt the content and information in a lesson was 'easy to understand' give it a high clarity rating, and if you felt that the lesson was 'confusing' and 'unclear' give it a low clarity rating"*. Engagement was defined on the survey as: *"Engagement is simple. In your opinion did the lesson get you doing interesting things. If it did, give the lesson a high engagement rating, if it did not, give it a low rating"*. Figure 2 below provides a comparison of the clarity ratings and the engagement ratings for each of the six lessons collapsing over the eight field test sites.

Figure 2



The last part of the student survey are the written responses to two questions about what the students ***liked most*** and ***liked least*** about the *Biology of Sleep*. These responses will be discussed later.

Teacher rating data came from an overall survey, as well as activity based rating sheets. Tables 6 and 7 below summarize *Implementation Support* and *Lesson Content*. Both areas were rated on a four-point scale, with the higher value more favorable. The clarity and usefulness of three areas of *Implementation Support* were rated, and the overall clarity and usefulness of the content of each of the six lessons was also rated (Table 7).

Table 6
Teacher Survey: Implementation Support Aggregated Ratings (Sleep)

	Clarity	Usefulness
1. Organization of Lessons	3.6	3.4
2. 5E Instructional Model	3.6	3.2
3. NSES Standards	3.4	2.6

Table 7
Teacher Survey: Content Lesson Aggregated Ratings (Sleep)

	Clarity	Engagement
Pre-Lesson: Sleep Diary	3.6	4.0
1. What is Sleep?	3.0	3.0
2. Houston We Have a Problem	3.2	3.6
3. Do You Have Rhythm?	2.4	3.0
4. Evaluating Sleep Disorders	3.8	4.0
5. Drowsy Driving Policy	3.6	3.6

Tables 8 and 9 provide a closer look at teacher ratings of particular activities within the six lessons. While not every activity was rated by the teachers, these activities were looked at from the perspective of "teacher materials" (Table 8), and "student materials" (Table 9).

Table 8
Sleep Aggregated Teacher Lesson Ratings of Teacher Materials

	Sleep Diary n=10	Tripp Grdnr n=9	What is Sleep n=6	Hstn prblm n=10	Siffre story n=3	Sleep scale n=10	Rhyt hm of sleep n=6	N Sleep n=10	Sleep Drdrs n=8	Case studies n=10	Drwsy Drvng n=9
Introductory sections were helpful	4.7	5	5.2	5.2	5.7	5.2	5.2	5.4	5.5	5.8	5.5
Presentation strategies were helpful	4.9	4.7	5	5.2	5	4.9	4.8	5.3	5.5	5.8	5.4
Procedures for students were clear	4.6	5.1	5	4.9	4	4.2	5.2	4.7	5.5	5.4	5.3

Table 9
Sleep Aggregated Teacher Lesson Ratings of Student Materials

	Sleep Diary n=10	Tripp Grdnr n=9	What is Sleep n=6	Hstn prblm n=10	Siffre story n=3	Sleep scale n=10	Rhyt hm of sleep n=6	N Sleep n=10	Sleep Drdrs n=8	Case studies n=10	Drwsy Drvng n=9
Reading level appropriate for students	4.4	4.8	5.3	5.3	5.3	5.4	5.2	5.4	5.8	5.6	5.4
Conceptual level appropriate for students	4.7	5	5.5	5.5	4.7	4.9	4.8	5.1	5.8	5.5	5.4
Material engaged and motivated students	5.4	4.4	5.2	5.5	3.7	4.9	3.7	5.2	5.5	5.6	4.4
Material helped students construct understanding	5	4.6	4.8	5.3	4	4.7	4.4	5.2	5.3	5.7	4.8
Materials for activities were worthwhile	5.3	4.4	5	5.6	4	4.8	4.2	5.3	5.3	5.5	4.7

Table 10 is designed for use by the BSCS writing team. This table organizes teacher narrative information found in Appendix E on a Lesson and Activity basis. In this way the cumulated teacher comments for a particular *Biology of Sleep* lesson and activity may be easily found and thereby applied to the revision process. The **Discussion** section and **Recommendations** follow Table 10

Table 10 (Writer's Table)

	Lesson 1 Activity Table	
Activity	*Based on your experience with this module, what aspects did you particularly like?*	*Based on your experience with this module, what aspects would you change?*
1	Anytime students record information about themselves I have no problem with incomplete assignments. That is a plus. Kids liked using the data base to find answers to the questions. This activity is a good vehicle for practicing the scientific method.	Would like to see the database be more flexible (in the way the data is displayed.).
1	Good, interesting story. Engages students well. Leads to interesting conversation.	Story is too short and lacks details. Students would like to make direct comparisons - will lead to better interpretation, e.g. Gardner - "excellent physical condition" Tripp - no mention of physical characteristics.

	Lesson 1 Activity Table	
Activity	*Based on your experience with this module, what aspects did you particularly like?*	*Based on your experience with this module, what aspects would you change?*
1	1. Students were very much engaged in the activity because they were working with their own data. 2. They seem to be having a lot of fun tracking their sleeping habits. 3. They shared so many "sleep" related stories they seem to be excited about learning about sleep since it is an activity that they perform daily, yet they know very little about it.	Discussion questions on pg. 32 did not make any sense to me.
1	The students were all easily motivated to do this activity.	Some of the students struggled with some of the calculations necessary for the lesson.
1	Interesting story - made them think about the effects of sleep deprivation. Made them think about how long someone could go without sleep.	Maybe enlarge the topic to include other stories of sleep deprivation; perhaps its use in warfare or with prisoners (as a method of torture to elicit information).
1	Students were very engaged and motivated.	The math was very confusing. Students were lost, and it took me most of the period to help the students work through math. Filling in the transparencies (data collection for class) didn't get finished in this class.
1	They were engaged.	This is my basic class. They were totally lost by the math. I needed to correct about half their averages. Adding 13 to early morning really confused them.
1		This is my honors class. They had no problem doing the math.
1		This class was a little better with the math, and I understood the objective a little better.

	Lesson 1 Activity Table	
Activity	*Based on your experience with this module, what aspects did you particularly like?*	*Based on your experience with this module, what aspects would you change?*
1	Interesting outcome.	The test period should be 14 or seven days so that the number of weekend vs. weekdays is realistic. The average blocks need to include morning, afternoon and evening averages for caffeinated drinks.
2	The students' curiosity was engaged. They did not need to be prompted to come to the conclusion that severe sleep deprivation would lead to death.	More detailed stories about both cases of sleep deprivation. The Randy Gardner story was not clear about the running of the study by the U.S. navy. The kids thought there was another story--they are not the greatest readers.
2	Good statements, many open-ended. Lead to good discussion. Simple. Succinct.	Statement 3 - I can tell when I'm going to sleep -- Think about rewording. Students did not necessarily equate loss of consciousness with "going to sleep."
2	Good "shocking" (engaging) story. Some students were shocked to find that you could die from not sleeping (sleep deprivation).	
2	Stories used to help introduce the topic. Also, the explanation to the activity 2 questions.	None.
2	Some of the questions elicited interest and follow-up questions.	I think question 4 is so simplistic it should be eliminated. Duh! Questions 7 and 11 are so similar that one of them should be eliminated. The pre-test and this questionnaire I did the same date - it was almost too much "testing" for one day. I think they lost interest a bit towards the end of the discussion.
2		This is my honors class. The students started out being engaged, but then got bored because they knew the correct answers and there was little discussion.
2		Much good debate in this class. Very engaged and interested in discussion.

	Lesson 1 Activity Table	
Activity	*Based on your experience with this module, what aspects did you particularly like?*	*Based on your experience with this module, what aspects would you change?*
2		Most students knew the correct answers, so there was very little discussion in this class. Students didn't engage in this discussion.
2	Interesting story.	The discussion was very short as written, it is unclear how long humans can survive.
2		This class was very engaged and very interested in facts of sleep. We slept the whole time in discussion.
3	I liked these questions. They really got the kids talking and thinking about sleep. I found it especially powerful showing them the answers and explanations after we finished the entire module. They laughed at their own original answers.	
3	Students collecting real data. Students learn about themselves. Students well motivated.	Leave calculators for another copy master with own directors. Students filled in charts often with incorrect formulae. Better if model was with actual calc. sheet. Sleep diary asks for average number of caffeine drinks. Need to differentiate between morning, noon, night for database.
3	Some misconceptions were clarified.	We took the pretest on the same day and they got tired of taking so many tests. This was not very engaging.

	Lesson 1 Activity Table	
Activity	*Based on your experience with this module, what aspects did you particularly like?*	*Based on your experience with this module, what aspects would you change?*
3	Students were automatically interested in tracking their information.	On the Sleepiness Scale - The first observation for the day and the last observation both give a range rather than a point in time. Does this mean take any point in time within that range during which the subject is awake? That is the way in which I interpreted it. You should probably include some clarification of this point. On the Sleep Diary form, when you go to enter your data on the NIH website, they ask for average number of caffeinated drinks for morning, afternoon and evening separately, but on the form there is only one spot. The form should be modified so that it matches what categories you are to input on the website.
3		Slightly redundant questions.
4	Use of web to pool large amounts of data - better representation of trends. Easy to manipulate. Clear expectations on each web page.	It was not initially clear to me that the teacher admin. page was NOT where my students were to start. Best to have the web (main) page with access for everything so everyone has a common start point. Custom Database needs to indicate total number of records in the db so students can see and calculate what % falls under the conditions they set up. Suggest specific tasks students might complete with db.

	Lesson 2 Activity Table	
Activity	*Based on your experience with this module, what aspects did you particularly like?*	*Based on your experience with this module, what aspects would you change?*
1	I loved this activity. It is inherently engaging. The graphics are wonderful.	The reading level was way above that of my students. They got stuck reading the reference material and trying to decipher the similarities between the astronauts EEG, EOG, and EMG and the samples. Their comments in the surveys show their frustration.
1	Website easy to use. Good comprehension skills for students. Good analysis. Practical data application.	Master 2.2 needs reworking. See page 41 of teacher manual for details on my comments.
1	Students enjoyed video portion of the lesson. Students found it very interesting that they were using internet as a part of their class lesson.	I had to go over what EEG, EMG, and EOG meant after the lesson--not clear.
1	The students found this activity very engaging.	None, there were just a few glitches with the web site.
1	My students loved working on the website. They liked the interactivity of it.	Master 2.2 Astronaut Telemetry Evaluation Form - The order of the categories on the form doesn't match the order of categories on the website. It should. Students tried to enter the wrong info due to this.
1	Great activity. I overheard a student say, "boy did I learn a lot-and it was fun! I learned about EEG, EMG's, and it was painless."	
1	This is my honors class, and they loved this activity, two thumbs up!	
1	This is my basic class. Only two students have any problem with this. Because they were in a group, other members helped them.	
1	Required analysis.	It was a little confusing to figure out what needed to be copied. We ended up using the handouts with the computer. It would be useful to have the Internet address on the handout. Only 4 computers could operate at one time.
2		The students were not engaged by this activity. I can't think of another idea that would introduce the idea of circadian rhythms in a more interesting way. I was confused how his day varied between 18-52 hours and would like to have something to tell my students. What wavelengths of light are needed to reset the clock? Why did the maps throw off his clock if his sleep was controlled internally?
2	Interesting story.	Handing out masters of 3.4 & 3.5 before reading Michel Siffre story might have helped students understand the concept of 24.5 hr circadian clock cycle better. Separately written out discussion questions might have helped clarify the instruction.

	Lesson 2 Activity Table	
Activity	*Based on your experience with this module, what aspects did you particularly like?*	*Based on your experience with this module, what aspects would you change?*
2	The students enjoyed reading about an actual experience.	None.
2	Discussion.	It was strange to keep passing out reading materials, it made the lesson feel choppy.

	Lesson 3 Activity Table	
Activity	*Based on your experience with this module, what aspects did you particularly like?*	*Based on your experience with this module, what aspects would you change?*
1	The graphs very clearly showed that their sleepiness increases over the course of the day. About 50% of the students saw the dip in alertness	I am so confused. When the students graph their shift in sleepiness scores and let's say that they are getting sleepier from one measurement to the next by increments of 2. The shift in score is the same and the graph will be flat. The students misinterpret this as no change in sleepiness.
1	Graphing skills are important. Mathematical manipulation of data -- good.	Graph template is lousy. Boxes rect. instead of square. Leave labels off -- allow students to construct graph themselves. Let them pick units, labels, title, etc. This is an important skill for students to learn. Time selections may be problematic. We got a good dip trend in one class and nothing in the second. When I averaged the two classes together the trend was also gone. I hate telling students "Well this is what is supposed to happen". The data should speak for itself. 2:00 (dip) time is a common dismissal time in our area. May not show correct trend.
1	Most students' graphs were similar although their first Monday was a bit off (it was a holiday--Presidents day) Instruction was very simple to follow.	Sleepiness scale did not really make them understand the biological clock. They did not see a good pattern. Is there any other activity?
1	Students, for the most part, could easily see their own circadian rhythms.	Some of the lower-end students had trouble with the math & graphing.
1	Good math activity.	It's a pretty confusing activity. I'm not sure it has anything to do with the way in which it was put together, but more with the intrinsic nature of the activity. In the Sleepiness Scale Score a larger positive number means you're getting sleepier. But in the Sleepiness Scale Shift in Scores, a larger positive number means you're getting more alert. That was confusing when we did it as a group of teachers, and it was confusing to the students as well. I"m not certain that students take home a lot as a result. The point you are trying to make is obscured by the difficulty of the assignment designed to make this point. Of all the assignments, this is the one I would be most likely to eliminate.

	Lesson 3 Activity Table	
Activity	*Based on your experience with this module, what aspects did you particularly like?*	*Based on your experience with this module, what aspects would you change?*
1	We had a double period for lab. This allowed the students to graph their data in class. This was superior to the first-class which was supposed to do it for homework.	
1	Students in this class have an extra numeral 20 minutes. I helped to make the graphs. They were very engaged and interested in finding out about themselves.	Finding shift-scores was difficult for basic students.
1	Students were interested in finding out about themselves.	Many of the students didn't do it for homework. So students only made 1 line on their graph. I needed to give better directions but I ran out of time because of the math problems.
1	Analysis and math skills.	The students were confused on how to graph the 3 days. Data couldn't be entered into computer.
2	Good story - interesting.	The activity is not doing much - concept conveyance is very simple. It takes too long to convey a simple, simple concept.. Again, like the first story, more details would be valuable.
2	The Siffre Story is interesting and did act as a "gotcha" for my students.	Item 6, pg 50 - the info referred to here is not in the top half of the handout.
2	This is my basic class and they were very interested in biological clocks.	
2		This would have been better with some hands-on activity. Students weren't too engaged with the discussion.
2	Added a little piece of information at a time.	My third period class didn't engage.
2	from	This is my honors class. They know about biological clocks, so there was limited discussion.
3	I used the cross curricular emphasis (geography). Our students are really weak in this area. I personally enjoyed doing the activity. I think it might even be more fun if the kids were to actually plan the new tour in the same format as the original. You could provide a list of available flights. I say this because my students at first were confused about filling the "days to Adjust" column for the flights until they discovered the order did not match their revised list.	The kids were very frustrated with the map. Having clear lines for each time zone.

	Lesson 3 Activity Table	
Activity	*Based on your experience with this module, what aspects did you particularly like?*	*Based on your experience with this module, what aspects would you change?*
3	Interdisciplinary use of geography and science.	Students really disliked this activity. It did not challenge them and the concept was not very plausible. The initial schedule doesn't make sense. Perhaps a better strategy is to provide all sites to be played in alpha order and have students create the schedule. Give them date range for tour and have them construct. Why change schedule?? Instead, create. Provide a better map. Provide a suggested answers section. I think this activity would have worked better if the scenario was more plausible. Aside: Students did not think the band name was humorous - was actually a turn off.
3	It was fun to watch students trying to figure out what country each city was in. Students were really interested to find out about jet lag, since many were planning to travel the spring break. It was a very relevant lesson.	As we discussed before the time zones were hard to see and so the names of the countries. The website helped. Could we have an answer key?
3	The students were easily motivated to complete the activity.	Several of the students struggled with the time zone map since they had a hard time reading the geography.
3	A good activity.	N'SLEEP is probably a bit too contemporary. If this group breaks up or loses popularity what my currently be "hip" will become "passe" or irrelevant. If you want the curriculum to stand the test of time (to be used in future years) you may not want to saddle it with what may become a dated reference. The time zone map sucks! Even the one on the website isn't that good. It doesn't show Zurich, for example.
3	Once students engaged they worked hard on the activity. They learned geography along with biological clock.	
3	Good activity.	The map was very hard to read!
3	Students loved the activity. Very engaged and learned a lot about geography.	
3	Good idea, "N'SLEEP" tour. The students thought it was clever.	Need a better map, students couldn't find Zurich or Moscow. Students were very interested and engaged while others didn't understand what they were doing or why. The directions were unclear.
3	Very interested in the activity, loved the idea of the concert tour.	

	Lesson 4 Activity Table	
Activity	*Based on your experience with this module, what aspects did you particularly like?*	*Based on your experience with this module, what aspects would you change?*
1	The reading level was high but the kids were able to extract enough information to finish the diagnoses. They really liked this. Kids love diseases. I loved that the kids made initial and final diagnoses. The kids who had Narcolepsy all made an initial diagnosis of insomnia . I would like to see more ambiguous primary information on the patient's symptoms so as to make the analysis more challenging.	Rephrase the last question on the evaluation form to something like "patient's symptoms which match the disorder"--this was confusing.
1	Handout was very engaging. Lot of students commented as they were reading and some laughed. When I asked the #6 question (at you, or a member of your family, ever experienced a sleep disorder?), almost all students participated in eagerly shared their own or family members' sleep disorders. There were so many funny stories. Especially ones about sleepwalking. However, through this discussion, they seemed to understand the destructiveness of sleepwalking. Some students brought up the news about a man stabbing his wife while he was sleepwalking.	
1	The actual stories easily motivated the students.	None.
1	They were a little bit interested in the last part - how loud snoring can be. It does serve as a kind of natural intro to sleep disorders.	I'm not sure this activity achieved its objective. Snoring is so commonplace that there really wasn't a whole lot of interest generated by this activity. I would probably get rid of it. It doesn't serve its "gotcha" function. My students were more like "why are we doing this?"
1	In this basic class, students really got into the discussion. One student shared howl loudly his dad snores. We talked about how do you respond to the snoring.	
1	Discussed fairness of laws against snoring.	
1	In this class the discussion turned into a nice introduction to the case study activity.	
1	Critical thinking, cooperative.	"Inadequate sleep hygiene insomnia" isn't listed in the manual
1	Students were engaged. I couldn't believe people could snore or at 90 decibels. Another student said his grandmother does.	
2	Cute stories-- the kids wondered if they were true. Good substitution for the "Sleepwalking Killer."	
2	Students role playing - interpreting data - drawing conclusions. Very strong activity - well received. Good questions to ask students.	Incorporate more content, e.g. Q's bottom of page 62 into student materials.

	Lesson 4 Activity Table	
Activity	*Based on your experience with this module, what aspects did you particularly like?*	*Based on your experience with this module, what aspects would you change?*
2	All students participated in the group discussions. I was able to observe students thinking critically (great lesson). Students worked on more than one case. Many students commented that they might have restless leg syndrome.	Make 1 copy per student--master 4.7. Some students wanted to keep them for their information and share with family.
2	Most of the students were very interested to learn about the sleep disorders.	Some of the lower end students had a hard time with the vocabulary involved in the reading. This, however, really can't be avoided.
2	I thought this activity was interesting and a good way to get across the types of different sleep disorders.	I don't think my students thought that much of the activity. After the astronaut simulation which was similar but Internet based, this seemed a bit "old hat" to them. (Maybe it was the way I presented the material to them rather that the material itself.) As I said above I thought it was a well constructed activity.
2	Students were very engaged. Worked and learned. Like "being doctors."	
2	Students engaged quickly. They're really like this one.	
2	This was a great activity! In one group discussion, one student had his group hold their breath for 30 seconds to describe apnea.	
2	Honors kids engaged with this activity.	
2	Interesting.	

	Lesson 5 Activity Table	
Activity	*Based on your experience with this module, what aspects did you particularly like?*	*Based on your experience with this module, what aspects would you change?*
1	The kids loved this. They loved voting on the final questions. They brought up the main points about the biology of sleep and safe driving: caffeine does not control sleep--your brain does--sleep is brought on cyclically and there is nothing that can be done.	I am not sure how this connected biological issues with social problems. I don't know if I would spend the time to do an exercise like this. The idea that sleep is controlled by an internal clock is taught in previous lessons!!
1	Students worked cooperatively. Well engaged. Its hard to write good test questions - students learn good communication type skills, e.g. how will other read their work and interpret.	Younger students do not drive. My older students related well, but my younger ones did not. This surprised me, as I thought something that would affect them down the road would be important. I think a little more clearer objective on what types of questions (e.g. T/F, M/C) should be examined.

	Lesson 5 Activity Table	
Activity	*Based on your experience with this module, what aspects did you particularly like?*	*Based on your experience with this module, what aspects would you change?*
1	The students easily could compile lists of good & bad sleep habits after completing the previous activities.	Maybe if more of an explanation was given as to why Meecham closed his eyes, the students would understand the newspaper articles a little better. They knew he was fired; they wanted to know why.
1	A good summative activity in the sense that they had to collate and sort out the info. They felt that was important out of the total info presented.	Not an intrinsically interesting activity. I gave extra credit if the individual questions submitted initially survived the winnowing process. Without this I'm not sure how interested they would have been in pursuing it. It'd be nice to end up the unit with a bang rather than a whimper.
1	Brainstorming was a great review of all the we learned this week.	Did not like making questions.
1	Brainstorming was good and bad sleep habits covered most of the material we cover this week.	The driver's license questions didn't show any depth of understanding of all they learned to this week. They asked questions like, "what percent of accidents are caused by sleepiness?"
1	Brainstorming was a good review.	The driver's questions were not good. Pick unimportant statistics to test.
1	Assimilates knowledge.	
1		I was bored with brainstorming about the good and bad sleep habits.

DISCUSSION

This section discusses patterns in the statistical data and corroborates these patterns with the student narratives, teacher narratives, and evaluator interviews and notes in Appendices D, E and F bound separately.

The strongest statistical pattern occurs in the pre-post test means (Figure 1 and Table 1). All eight sites exhibited an increase from pre-test to post-test. For six of these eight sites this improvement was statistically significant at the .01 alpha level. While the other two field test sites were not statistically different, there was a modest increase in average post-test scores.

The predominant finding in Table 2 is that most of the students (i.e., 88%) rated the *Biology of Sleep* module as *just right*. It is worth noting however that the percentage distribution of ratings across the three categories (i.e., *too easy; just right; too difficult*) varied from state-to-state. In particular the Connecticut students showed the highest percentage (i.e., 29%) of students rating the module as *too easy*. This percentage was considerably higher than the next highest percentage, which was California, where 9.6% of the students rated the module as *too easy*. During the Connecticut site visit the evaluator noted that the biology classes there were honors level. Also, the teacher in Stamford had received numerous science teaching awards and thus was more likely to attract top students. During the interview phase of the site visit one student remarked that he wanted more "molecular theory" in the biology class (in general), and that this module (in particular) did not meet that expectation. Also during the interviews it was remarked that *Biology of Sleep* might be an excellent module to be placed within a "Health Sciences" curriculum sequence. On the other side, almost 12 percent of the Iowa students indicated that the module was *too difficult*. This observation dovetails with the statistics in Table 1 where the Iowa students had the lowest average *pre-test* result. Finally, though the Iowa students rated the module as more difficult relative to the other seven sites, they nonetheless improved significantly on the post-test.

Examination of Table 3 supports the observation above about the possible interaction between the module materials and "level" of the students. Specifically, in Connecticut only ten percent of the students used the descriptor *challenging*, the lowest percentage among the eight field test sites. The descriptor *confusing* was applied the least number of students in six of the eight sites, where Montana and Connecticut the students chose *confusing* more often than they did *challenging*. The marginal percentage is smallest for *confusing*. The strongest adjectives were *fun* and *active*. The Hawaii students selected *fun* the most often, whereas the Illinois students selected *active* the most often. Overall the descriptor *fun* was selected the most often across all of the five adjective descriptors.

Figure 3 on page 19 shows that the overall student rates for each of the six lessons (i.e., pre-lesson, and lessons one through five) were higher for clarity than engagement. Lesson 3 (Houston We Have A Problem) was relatively the lowest in the group, whereas the Pre-Lesson (Sleep Diary) was relatively the highest among the six. Lessons 1 (What Is Sleep?) And Lesson 5 (Drowsy Driving Policy) showed the largest discrepancy between clarity and engagement (i.e., these lessons were clear but relatively less engaging). The results in Figure 3 may be further analyzed by examining Tables 4 and 5, as well as the student narrative in Appendix D.

Students were asked to write about what they *liked most* and what they *liked least* about the *Biology of Sleep* module. Overall this narrative record (see Appendix D) corroborates the statistical patterns. Within the student narrative record the *Sleep Diary* was very well received:

> *"I like doing the sleep diary because I got informed of how much I sleep on average. I now know that I also need more sleep!" [page D-23]*

> *"I liked the sleep diaries because it actually showed me how much I slept and drank caffeine. And I think it is better doing things like this." [page D-43]*

> *"I liked the way it involves a lot of group work. The sleep diary was my favorite part because it told me something about how I sleep. This whole unit [i.e., Biology of Sleep] was interesting." [page D-71]*

Based on a reading of the narrative transcript approximately 28% of the positive comments (i.e., *liked most*) dealt with the sleep diary. In contrast, only about 8% of the negative comments (i.e., *liked least*) dealt with the sleep diary. Those that did not like the sleep diary seemed not to like it because they had to remember to write down the times that they woke in the morning or went to sleep at night.

In the student narrative, the first lesson (*What Is Sleep?*) received the least attention. About 4% of the positive comments focused on this lesson, and about 4% of the negative comments focused on this lesson.

Lesson 3 (*Houston We Have A Problem*) received the largest mix of positive as well as negative comments. On the *least liked* aspects of Lesson 3, students objected to the number of forms that they had to complete, which relates to the confusion expressed by this unit.

> *"I did not like the "Houston We Have A Problem" unit. It was completely confusing to me. I think that it was hard to tell if the astronaut was in NREM sleep or REM sleep. The questions we had to answer were also not clear to me so therefore I did not like this lesson." [page D-2]*

> *"I really did not like the activity of Houston We Have A Problem because we had to do too much copying." [page D-4]*

Nearly thirty six-percent of the negative comments dealt with this lesson. However, approximately twenty-two percent of the positive comments also dealt with the Houston lesson. In particular students liked using the computer, the notion of telemetry and trying to figure out something at a distance.

"I liked the telemetry activity because we got a chance to determine if the astronauts were sleeping or awake, and because it was fun." [page D-10]

"I liked it because I think sleep is very interesting; the way you can measure the EEG, EOG, EMG. And how you can tell if the person is sleeping or awake." [page D-17]

These narrative comments reinforce the statistics found in Tables 4 and 5. For example, this lesson received the highest percentage of "medium-low" ratings (22.5%) on the clarity scale relative the other five lessons.

The third lesson (Do You Have Rhythm?) received the strongest negative comments, which tended to come from one of the field test sites. There were two objections: 1) the time zone map was difficult to read; 2) the band name NSynch was too "gimmicky". It is this latter observation that drew the strongest reaction.

"I also think that the name N'Sleep sucks a lot!" [page D-5]

"I did not like the N'Sleep thing because the title was not appropriate for our quality work." [page D-5]

There were a number of Houston comments that related in one way or another to time zones and the confusing time zone chart (e.g., small print, difficult to read, lack of geographic reference points).

"I also did not like "Do You Have Rhythm" because the time zones and days to adjust, and revised schedule were pretty confusing. I was not sure what to do and how to revise a new schedule in which the group would not get affected by jet lag." [page D-2]

"I did not understand the time zones and how to do the days to adjust." [page D-16]

The students that liked Do You Have Rhythm (i.e., about 16% of the positive remarks) enjoyed learning about jet lag.

"The N-Sleep tour, I liked it because it made me learn a lot for example, that traveling towards the west minimizes jet lag and that you need one day to adjust to two time zones crossed, and also because it was challenging and fun." [page D-10]

The fourth lesson (*Evaluating Sleep Disorders*) produced some interesting comments that relate to critical thinking skills. While only about 19% of the positive comments dealt with this lesson, that percentage is nearly twice the percentage of lesson 4 negative comments. Students

that liked this lesson (many from CT), liked it because they had to think about, and process a diagnosis based on evidence. On the other hand students that did not like this lesson, did not like it for precisely the same reason (that it made them think).

> *"I like evaluating sleep disorders because we got to diagnose patients with different symptoms."*

This activity was observed in one of the CT classes and the project evaluator noted the high level of interest in this particular lesson.

The fifth lesson (*Drowsy Driving Policy*) received a lower percentage of comments in the student narrative (i.e., about 11% of the positive comments, and about 10% of the negative comments). The negative comments regarding Lesson 5 were that it was "boring". On the positive side, some students genuinely appreciated learning about the impact of drowsiness on driving. Table 11 below presents the approximate percentages across all six lessons, where percentages in each column are based on column totals.

Table 11
Distribution of Student Narrative Comments

	Percent of Total Positive Comments	**Percent of Total Negative Comments**
Pre-Lesson: Sleep Diary	28%	8%
1. What Is Sleep?	4%	4%
2. Houston We Have A Problem	22%	36%
3. Do You Have Rhythm?	16%	31%
4. Evaluating Sleep Disorders	19%	10%
5. Drowsy Driving Policy	11%	10%

Teacher comments (Appendix E) as well as evaluator class interviews and observations (Appendix F) are valuable in their specificity. That is, when examined, the content may be applied directly to the revision process, particularly the teacher comments. The transcripts from the evaluator student interviews in Connecticut provide useful insights into how students view the material. For example, in one student-interviewer exchange the students (an honors class) expressed a desire to have more molecular level material, while appreciating the "diversity" of activities associated with *Biology of Sleep*. Table 10 above organizes the teacher comments on a lesson-by-activity basis. While this teacher narrative record is most valuable in the "whole", some important teacher comments refer to such items as: 1) more detail in the stories; 2) more flexible database; 3) less confusing map; 4) better reconciliation for rising sleepiness scale scores and falling shift scores; 5) fewer handouts, where so many handouts make the lessons feel "choppy".

Overall this was a very successful module. The strengths were in its diversity, and level of engagement by most of the lessons, though not all. In particular, data "about self" is inherently engaging and interesting (i.e., sleep diary). Artificial data, or contrived examples are less engaging for the students. For example, the "true" case studies were successful, though they could have had more detail and perhaps been more fully integrated into the flow of the lessons. The sleep diary was particularly successful, although some of the associated methods of collecting data via worksheets was less successful. The last page contains a series of recommendations based on the data in this report.

RECOMMENDATIONS

1. Retain sleep diary;

2. Revise Houston database to be more flexible;

3. Expand "Evaluating Sleep Disorders", perhaps by linking case studies more closely with disorders;

4. Redesign sleepiness scale and shift scores to more clearly and more directly illustrate circadian rhythms;

5. Emphasize "real" data from actual people, which might include adding an in-class experiment on apnea (e.g., holding one's breath to create an abnormal breathing pattern);

6. Reconsider NSleep name. Although the name was not a serious problem with most students, it did create a strong reaction for some. Perhaps "naming the band" could be part of the activity;

7. Make a series of minor adjustments such as: fewer worksheets, improved time zone map, easier ways of collecting and aggregating sleep journal data;

8. Improve data collection methods throughout module. Reliance on numerous worksheets gave some of the lessons a choppy feel. Perhaps an integrated data workbook, or distributed acetate sheets for overhead presentation might reduce number of worksheets necessary throughout module;

9. Maintain or increase level of interactivity for students (i.e., discussions, short presentations, data analysis discussion pairs);

10. Discuss the relationship between module and curriculum, where curriculum might be honors vs general, or biology vs health science;

11. Emphasize utility of non-textbook type module for students, which allows them to focus on particular material not distributed throughout a textbook, and to write notes on their materials.